SECTION 11710
LIQUID NITROGEN (LN2) STORAGE AND TRANSFER LEASE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings P7.50.31, P4.B1.51, P5.10.01, P5.10.02 and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.2 SUMMARY

A. This specification includes a cryogenic storage tank, related accessories, a truck fill station line and a vacuum jacketed transfer line. All components to be leased for 10 years at which time SNS shall purchase the system.

B. The leased storage tank system will provide bulk storage in support of the SNS target building. The storage tank will be installed as part of a transfer system. The transfer system will be used to load LN2 into portable dewars, and supply GN2 to the target building facility for general use. The LN2 storage area shall be provided with complete pneumatic controls which can be used to manually set the operating pressure of the tank between the ranges of 0 to 150 psig.

C. Installed Location: All tanks and associated components will be located at the Oak Ridge SNS facility.

D. Commodity to be stored is liquid nitrogen (LN_2).

E. Transfer of cryogens from the storage tank will be accomplished by means of a pressure building vaporizer to pressurize the storage tank and flow cryogens to the facility users. Cryogens will be transferred to the dewar fill stations via a 1X2.5 vacuum jacketed pipe to be included in the supply of the LN2 storage and transfer system. Isolation valves and relief valves shall be included in the LN2 storage system provider's scope of supply as indicated on the attached drawings. A 1-1/2" diameter sch 40S 304L SS truck fill station pipe shall also be included in the LN2 storage system provider's scope of supply.

1.3 SUBMITTALS

A. Six (6) copies of product data to be provided including nominal capacity, actual capacity, and pressure rating of selected models; weights (shipping, installed, and operating); furnished specialties; and accessories. Indicate dimensions, finishes and coatings, required clearances, methods of assembly of components, and piping connections.

B. Provide tank system site layout drawings which locate tank and its concrete base, pressure building vaporizer, vacuum jacketed piping routing, truck fill station piping and pipe supports and locate (with coordinates) facility interfaces.

C. Provide data reports confirming successful pressure/leak testing.

D. Provide data reports confirming successful system cleaning.

E. Stress analysis calculation for truck fill station line and vacuum jacketed transfer line compliant with the requirements set forth in ANSI B31.3 complete with layout drawing(s) indicating nodes and locations of supports.

1.4 QUALITY ASSURANCE

A. American Society of Mechanical Engineering (ASME) Compliance: Fabricate and stamp storage tank to comply with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

B. Piping shall be per the requirements of ASME B31.3, Process Piping Code, 1996 version or later.

PART 2 - REQUIREMENTS

2.1 GENERAL REQUIREMENTS

A. Seismic Requirements:
1. Design tanks, accessories, and supports for lateral and vertical loads caused by a PC-2 seismic event per UBC 97.
2. Use an important factor associated with a hazardous facility and a site coefficient equal to 1.0.

2.2 WIND REQUIREMENT:

A. Design tanks, accessories, and supports for loads caused by an 85 mph wind, Exposure C and an importance factor associated with a hazardous facility.

2.3 ELECTRICAL REQUIREMENT:

A. Storage Tank system shall be completely pneumatically operated.

B. Grounding shall be applied for static and lightening protection in accordance with NFPA guidelines

2.4 DISCRETE DEVICE REQUIREMENTS:

A. No monitoring capability is required

2.5 ANALOG DEVICE REQUIREMENTS:

A. No control capability is required

2.6 LN_2 TANK REQUIREMENTS

A. Storage Tanks, Piping and Accessories:
1. Total storage required (including ullage) is 6,000 gallons. Total storage quantity shall not be met with multiple tanks of the same size.

B. Tank and Piping Pressure Rating:
1. The tank maximum allowable working pressure shall not be less than 250 psig.
2. Pressure rating of piping shall not be less than 150 psig.

C. Net Evaporation Rate (NER):
1. A NER of 0.5% or less, over a 24-hour period, for conditions commensurate with an ASHRAE 97% day and 2.5% wet bulb, is required for the storage tank.

D. Tank Configuration:
1. The storage tank shall be a vertical design of with an installed height to provide the required head pressure to drive the vaporizer at the conditions provided in section 2.12.

E. Construction:
   1. ASME code stamp, designed for LN_2 storage, 250-psig maximum allowable working pressure.

F. Accessories:
   1. Tank shall include isolation valves, relief valves, burst discs, pressure gage, pressure transducer, and fluid level gage as shown in the referenced drawing.
   2. Provide a box or marshaling enclosure to which all control system pneumatic tubing signals are terminated. This box shall include hand operated pneumatic controllers for selecting the tank operating pressure.
   3. Pressure rating for all tank accessories shall not be less that 250 psig.

2.7 LN_2 COMPONENT SYSTEM REQUIREMENTS

A. System Configuration:
   1. Pressure building tank, and pressure building vaporizer shall be configured to require a minimum of ground space. Complete assembly shall fit into the footprint outlined in drawing P4.B1.51
   2. Tanks, manifolds, components shall be physically arranged in the most cost effective and operationally efficient manner and shall be approved by the client.
   3. Tank shall have a common fill and liquid draw manifold constructed of
   4. 304L or 316 SS. All piping associated with this tank shall be constructed of 304L or 316 SS.
   5. Relief valves shall be provided in all lines in which cryogenic fluid or gas can be trapped between isolation valves. Relief valve outlets shall be directed toward the ground or away from potential contact with operating personnel. Facility engineer to provide approval of relief valve vent locations prior to field assembly.
   6. Purge line taps shall be provided in the system lines. Purge vent outlets shall be vented to a safe location to eliminate any safety hazards which may result from free venting nitrogen.
   7. If valves or components are located on the top of the storage tank, a permanent ladder and access platform must be provided with the tank.

2.8 REMOTE ACTUATOR VALVES:

A. All valves shall be sized to meet the required flow rates and pressures defined in section 2.12.

B. Provide all remote isolation and control valves complete with operators as required by the process and control design. System shall be pneumatically operated using gaseous nitrogen from the storage dewar. All associated system tubing, regulators, speed controls, and manual valves shall be provided. A single pneumatic panel with pressure control devices shall be provided and be located in a prominent and easily accessible area.

C. The pressure control valves for the pressure building system shall have the ability to be set to a given pressure between 0 and 150 psig.

2.9 PRESSURE BUILDING VAPORIZER:

A. The vaporizer shall be passive, ambient type design and shall be sized to meet the required system flow rates and pressures defined in section 2.12 for continuous operation.

B. Multiple vaporizers may be used to meet the system pressures and flow rates requirements. However, the footprint identified in drawing P4.B1.51 shall not be exceeded.

2.10 CONSTRUCTION:

A. All piping shall be designed per the appropriate guidelines specified in ANSI B31.3.

B. Fill and liquid draw headers shall be 304 or 316 stainless steel pipe with weld or flanged end connections.

C. All manifold piping shall be designed to accommodate stresses induced by thermal contraction and expansion of the piping.

D. Tank system valves and components which require periodic servicing shall be designed to allow easy removal or repair.

E. Stainless Steel Pipe, Flanged Joint Bolts and Nuts: ASTM A320, Grade B 304 SS stud bolts, A194 grade 8 heavy hex nuts.

2.11 FACILITY INTERFACES:

The following tank system interfaces to the facility fill and transfer systems shall be provided.

A. Supply Line Facility Interface:
   1. One, 1" x 2.5" vacuum jacketed line. To be routed as shown in the drawings, terminated with a 6" inner line extension and an MNPT threaded connection for each dewar fill station interface.

B. Tank Fill Line Facility Interface: (located at the truck fill station)
   1. One, Bronze threaded type connection and cap having the thread pattern commensurate with the truck fill lines of the commodity vendor providing the system. Piping to be connected to the storage tank in the vicinity shown on the layout drawings

C. GN_2 Receiver Charge System / Supply Line Facility Interface:
   1. One, 2-inch raised-face flange connection in the vicinity shown on the layout drawings.

D. System Purges:
   1. 3/8-inch flared tubing or threadolet connections routed to common facility interface as required.

E. Valve Actuation Pneumatics:
   1. All actuated valves shall utilize nitrogen from the storage dewar.

F. Instrumentation and Valve Control:
   1. All instrumentation and valve control shall be terminated at a common facility interface and shall utilize nitrogen from the storage dewar.

2.12 PERFORMANCE:

A. The LN_2 tank system shall meet the following facility performance requirements under the atmospheric conditions commensurate with a 97% day and a 2.5% wet bulb as per ASHRAE guidelines.
   1. Maximum Liquid Draw Rate:
      a. 100 lbs/min at a minimum pressure of 100 psig (at the dewar fill interface),
   2. Minimum Liquid Draw Rate:
      a. 10 lbs/min at a minimum pressure of 10 psig (at the dewar fill interface).
   3. Maximum Gas Flow Rate:
      a. 600 lb/hr GN2 @ 120 psig (at the facility interface)

4. Minimum Gas Flow Rate:
   a. 60 lb/hr GN2 @ 120 psig (at the facility interface)
5. Pressure Building Vaporizer Control Range:
   a. 10-150 psig
6. Cleaning:
   a. Complete system (truck fill station line to storage tank to end of vacuum jacketed piping interface) to be cleaned to level 300 as per MIL-STD-1246C. Sample to be provided to confirm cleanliness level.

2.13 CRYOGEN QUALITY DELIVERED:

A. Cryogen delivered from the LN_2 tank system shall meet specification MIL-P-27401C, Grade A, Type I or II.

2.14 VACUUM JACKETED PIPING:

A. The Contractor shall be responsible for providing and properly installing vacuum jacketed piping which complies with ANSI B31.3. The design drawings are for general guidance. The Contractor shall verify the adequacy of pipe anchors, supports and dimensions. The system shall be analyzed by the piping manufacturer to ensure thermal flexibility. This analysis includes analysis of individual spool sections as well as the total system. Analysis shall include as a minimum: Allowable stress in piping, consideration for site conditions/constraints, anchors, supports and interface connections.

B. Piping spools shall be individually jacketed with vacuum and closure at each end. The installed piping shall, after stabilized conditions with -325 F fluid, have a maximum heat gain in accordance with the schedules below:
1. Rigid Piping Line Size, BTUH/hr-ft
   a. 3/4” OD X 1.25”NPS 0.37
   b. 3/4” NPS X 2” NPS 0.43
   c. 1” NPS X 2.5” NPS 0.47
2. Flexible Line Size, BTUH/hr-ft
   a. 3/4” OD X 1.25”NPS 0.97
   b. 3/4” NPS X 2” NPS 1.21
   c. 1” NPS X 2.5” NPS 1.43

Note: Fitting losses shall be included in these heat loss quantities for the complete, assembled system. Heat leak through other components (valves, filters, etc.) shall be as indicated by model number on equipment schedules.

C. Jacketed spools shall be factory tested and certified as having a stabilized vacuum retention of 25 microns mercury or less. Each spool assembly shall be fabricated with a seal off and relief valve, a bellows-sealed isolation valve and a thermocouple vacuum gauge tube. The seal-off valve shall provide a combination pump-out opening seal off and relief device. A no leak indication by mass spectrometer at 1E-10 scm (standard cubic cm) per second helium constitutes a successful test. Each spool assembly shall have a chemical gettering system installed during fabrication. The system shall be a calcium zeolite dessicant with a hydrogen absorber such as palladium oxide.

D. Bellows may be single or multiply. Bellows shall have a burst rating of 600 psig (4 times the system 150 psig rated design pressure). Design movement of bellows shall not exceed 75% of the maximum capability. Bellows shall have a life expectancy of 10,000 cycles at 70 F and 150 psig.

E. Welding-Joint Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of stainless steel pipe. Filler metals shall conform to AWS

A5.4 and A5.9 and be stored in areas that are moisture free. For 304L SS weldments use type E-308-ELC-16 coated electrodes, and/or either type ER-308L bare wire or type 347 bare wire. For 304 and 316 to 304 L welds, use type ER308L filler material

2.15 GLOBE VALVES (FOR VACUUM JACKETED SERVICE):

A. Globe valves for liquid nitrogen

Contractor shall make every effort to purchase cryogenic globe valves from the same manufacturer to limit the amount of spare parts inventory required by system operator.

1. 300 series stainless steel body construction with removable stem and extended bonnet assembly, designed for installation without disassembly, 150 psig working pressure, -325 F to +150 F working temperature. Polished internal surfaces. Body shall be either lost wax investment cast, ASTM A-743 grade, CF3 (304LSS) stainless steel or forged stainless steel, 100% radiograph inspected and factory tested for absence of hydrocarbons. Bonnets shall be a bronze alloy or stainless.
2. Liquid Nitrogen service: Buttweld ends with factory jacket. Butt welds shall be “true butt weld” construction with no closed-end cavities.
3. Kel-F, Teflon or polycarbon seats and bushings, with teflon or spiral wound graphoil seals; top access to seats (serviceable with out removal of valve from pipeline).
4. Valves shall be designed with a close tolerance fit, (0.003” or better) between the barrel and the body extension tube, such that valve orientation shall have no impact on leakage during flow operations and during periods of no flow.
5. Suggested Manufacturers include;
   a. PHPK (Type PV***)***
   b. CVI
   c. High Gear LO2 & LO20
   d. Circle Seal

2.16 RELIEF VALVES (FOR VACUUM JACKETED LINE SERVICE):

Relief valve mechanical type, flow capacity and pressure conditions to be determined by piping manufacturer based on the piping routing provided. Relief valves shall be rated for use in the piping class working pressure specified, application fluid and temperature. Contractor shall make every effort to purchase relief valves from the same manufacturer to limit the amount of spare parts inventory required by system operator.

A. All relief valve flow passages shall be 300 series stainless steel with stainless steel trim.
   1. Relief valves in nitrogen service shall have stainless lined flow passages and stainless trim. Seat material may be Kel-F, or Vespel. Seal materials may be Teflon or Viton.
   2. Relief valves connections shall have appropriate ratings with MNPT connections.

B. Suggested Manufacturers include;
   1. Anderson Greenwood
   2. Circle Seal Controls
   3. Fluid Mechanics
   4. Hydro’Seal

2.17 FLEXIBLE HOSES (This section is provided as a guide should the piping supplier choose to include them in the system routing for stress analysis purposes)

A. Except as otherwise noted, flexible metal hoses shall be designed, inspected and tested in accordance with ANSI B31.3 and with the applicable piping classes. Contractor shall make every effort to purchase hoses from the same manufacturer to limit the amount of spare parts inventory required by system operator.

B. Material of hose and braid shall be per ASTM A240-T321, T316L or T304L. For vacuum jacketed hoses, protective braids shall be installed on both the inner line and the jacket.

C. Working pressure, temperature, and end connections shall be as specified for rigid vacuum jacketed piping.

D. Flexible metal hose assemblies shall be an all welded construction and have a minimum life of 10,000 pressure cycles. Vacuum jacketed hoses shall be designed as flexible spools as specified in section 2.2. All hoses shall be Hydrostatically tested to 1.5 times the design pressure per ANSI B31.3 and cleaned to 300 per MIL-STD-1246C at the manufacturer facility before shipment and installation.

E. Suggested Manufacturers include:
1. Senior Flexonics Stainless Steel Products Division
2. PHPK Technologies Inc.
3. Minnesota Valley Engineering
4. CVI

2.18 EXPANSION JOINTS (This section is provided as a guide should the piping supplier choose to include them in the system routing for stress analysis purposes)

A. Contractor shall make every effort to purchase expansion joints from the same manufacturer to limit the amount of spare parts inventory required by system operator.

B. 150 psig LN2
1. Corrugated stainless steel bellows with butt welded ends, single or multiply. Bellows shall have a burst rating of 600 psig (4 times 150 psig design pressure.) Design movement of the bellows shall not exceed 75% of the maximum movement capability, and shall be rated for 10,000 cycles at 70 F and 150 psig.
a. Senior Flexonics Type MCB

PART 3 - EXECUTION

3.1 CONCRETE BASES

A. Tank Supplier shall provide the concrete requirements for pipe supports and concrete foundations for tanks and pressure building vaporizers to the owner for verification of existing designs.

B. Concrete bases will be constructed by others per design operating loads provided by the commodity supplier.

3.2 TANK SYSTEM INSTALLATION

A. Install tank on concrete base, level and plumb, firmly anchored, in locations indicated. Arrange so devices needing servicing are accessible.

B. Install pressure building vaporizer on concrete bases, level and plumb, firmly anchored, in locations indicated. Arrange so devices needing servicing are accessible.

C. Connect manifolds to tank and pressure building vaporizer and provide supports, guides, or anchors as required. Arrange so devices needing servicing are accessible. Bronze tags with chain type connectors shall be attached to each component and identify the component number.

D. Install pressure control and remote valves to pressure building system where indicated.

3.3 PIPING SYSTEM INSTALLATION

A. Install Vacuum Jacketed Piping, level and plumb, firmly anchored, in locations to be determined by stress analysis and in accordance with the guidelines herein. Arrange so devices needing servicing are accessible.

B. Install truck fill station piping level and plumb, firmly anchored, in locations to be determined by stress analysis and in accordance with guidelines herein.

C. Install pipe supports as needed in existing concrete foundations and structures.

D. Install pressure control and remote valves to pressure building system where indicated.

3.4 FIELD QUALITY CONTROL

A. Pressure Testing: Following the completion of the tank system installation the system shall pressure tested to the maximum allowable working pressure with gaseous nitrogen, at ambient conditions, and checked for leaks. All leaks must be repaired and the system rechecked.

B. Cold-Shocked Pressure Testing: After the successful completion of the system pressure test the system shall be pressure tested for leaks under cryogenic conditions. This shall be accomplished by loading LN_2 in to the system. The complete system (including storage area piping, valves, etc and vacuum transfer line piping valves, etc…) will then be inspected for leaks and repaired if required.

C. Prepare and submit written reports for specified tests two weeks prior to the testing date.

3.5 CLEANING

A. Commercial cleaning standard may be used provided each system can meet the required clean levels defined in supplier standard specification for oxygen systems and the system can provide croygens at the required specification requirements (defined in system performance).

3.6 COMMISSIONING

A. Initial Testing: perform the following test before filling tanks with cryogens:
   1. Ambient pressure/leak tests of tank system.
   2. Cold-shock pressure/leak tests of tank system with LN_2.
   3. Sample systems for cleanliness, moisture, and oxygen content.
   4. Documentation of test results to be provided for review and approval.
   5. System shall not be accepted until documented, approved test results are provided to the construction manager or his designee.

B. Filling Procedures: Follow commercial procedures for filling tanks. Fill tanks with cryogen to operating level.

C. Final Testing: Perform the following test after filling tanks with cryogen:
   1. Test operation of pressure building system.
   2. Test operation of tank accessories and devices.
   3. Documentation of test results to be provided for review and approval.
   4. System shall not be accepted until documented, approved test results are provided to the construction manager or his designee.

END OF SECTION 11710